

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 817 497 A3

(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
29.12.1999 Bulletin 1999/52

(51) Int. Cl.⁶: H04N 1/41, H04N 7/30,
H04N 7/50

(43) Date of publication A2:
07.01.1998 Bulletin 1998/02

(21) Application number: 96306903.4

(22) Date of filing: 23.09.1996

(84) Designated Contracting States:
DE FR GB

(30) Priority: 06.07.1996 KR 9627399

(71) Applicant:
SAMSUNG ELECTRONICS CO., LTD.
Suwon-City, Kyungki-do (KR)

(72) Inventors:

- Lee, Yung-Lyul
Karak-Dong, Songpa-gu (KR)
- Park, Hyun-Wood
Hoegi-dong, Tongdaemun-gu, Seoul (KR)

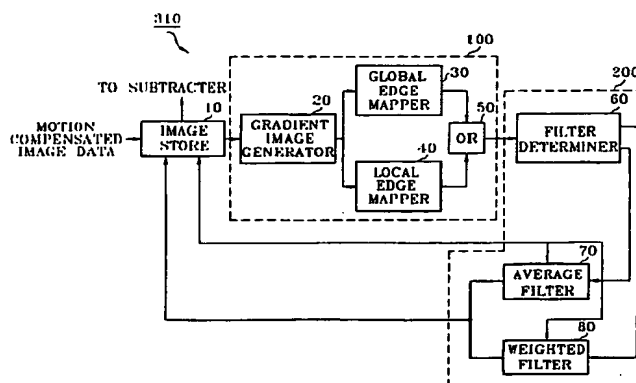
(74) Representative:

Neill, Alastair William
APPLEYARD LEES
15 Clare Road
Halifax, West Yorkshire HX1 2HY (GB)

(54) **Loop filtering method for reducing blocking effects and ringing noise of a motion-compensated image**

(57) A signal adaptive loop filter reduces blocking effects and ringing noise of motion-compensated image data. In the loop filter, binary edge map information on which global thresholding and local thresholding with respect to the motion-compensated image are reflected, is used to judge whether the binary edge map information within a predetermined size of the filter window is either a homogeneous or an edge area. If it is judged as a homogeneous area, predetermined first weight factors corresponding thereto are used for generating a filtered pixel value corresponding to the corresponding filter window. While, in the case that it is judged as an edge area, predetermined second weight factors are varied according to the binary edge map information corresponding to pixels, and the filter window having the varied second weight factors is used for generating the filtered pixel value corresponding to respective corresponding pixels.

FIG. 2



EP 0 817 497 A3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 6903

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP 0 613 302 A (PHILIPS PATENTVERWALTUNG ; KONINKL PHILIPS ELECTRONICS NV (NL)) 31 August 1994 (1994-08-31) * abstract * * column 4, line 12 - line 40 * * figure 3 *	1,5	H04N1/41 H04N7/30 H04N7/50
A	---	2-4,6-11	
Y	CHUNG J KUO ET AL: "ADAPTIVE POSTPROCESSOR FOR BLOCK ENCODED IMAGES" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, vol. 5, no. 4, 1 August 1995 (1995-08-01), pages 298-304, XP000528331 ISSN: 1051-8215 * paragraph '0A.2! * * paragraph '0A.4! *	1,5	
A	---	2-4,6-11	
A	YUEN M ET AL: "Performance comparison of loop filtering in generic MC/DPCM/DCT video coding" DIGITAL VIDEO COMPRESSION: ALGORITHMS AND TECHNOLOGIES 1996, SAN JOSE, CA, USA, 31 JAN.-2 FEB. 1996, vol. 2668, pages 462-471, XP002121732 Proceedings of the SPIE - The International Society for Optical Engineering, 1996, SPIE-Int. Soc. Opt. Eng, USA ISSN: 0277-786X * abstract * * paragraph '02.2! *	1-11	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04N
A	US 5 359 676 A (FAN ZHIGANG) 25 October 1994 (1994-10-25) * column 10, line 27 - line 60 * * abstract * ---	1-11	
-/--			
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 5 November 1999	Examiner Berbain, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03 82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 6903

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 577 350 A (MATSUSHITA ELECTRIC IND CO LTD) 5 January 1994 (1994-01-05) * abstract * * figure 5 * * column 4, line 52 - column 5, line 41 *	1-11	
A	EP 0 666 695 A (AT & T CORP) 9 August 1995 (1995-08-09) * abstract * * page 5, line 31 - line 41 * * figures 2,4 *	1-11	
A	HIROYUKI OKADA ET AL: "AN ADAPTIVE IMAGE QUALITY IMPROVEMENT METHOD FOR DCT CODING SCHEMES" PROCEEDINGS OF THE PICTURE CODING SYMPOSIUM (PCS), LAUSANNE, MAR. 17 - 19, 1993, 17 March 1993 (1993-03-17), pages 13.20/A-13.20/B, XP000346472 SWISS FEDERAL INSTITUTE OF TECHNOLOGY * paragraph '02.3! * * figure 1 *	1-11	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
Place of search THE HAGUE		Date of completion of the search 5 November 1999	Examiner Berbain, F
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/82 (P24C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 96 30 6903

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-11-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0613302 A	31-08-1994	DE 4305911 A	01-09-1994
		JP 6319131 A	15-11-1994
		US 5619267 A	08-04-1997
US 5359676 A	25-10-1994	CA 2125051 A,C	20-01-1995
		DE 69415887 D	25-02-1999
		DE 69415887 T	01-07-1999
		EP 0635985 A	25-01-1995
		JP 7154604 A	16-06-1995
EP 0577350 A	05-01-1994	JP 2624087 B	25-06-1997
		JP 6292173 A	18-10-1994
		KR 141082 B	15-06-1998
EP 0666695 A	09-08-1995	US 5512956 A	30-04-1996
		JP 7231450 A	29-08-1995

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82



Europäisches Patentamt
European Patent Office
Office européen des brevets



Publication number: **0 659 020 A2**

12

EUROPEAN PATENT APPLICATION

21 Application number: **94119781.6**

51 Int. Cl.⁶: **H04N 7/26**

22 Date of filing: **14.12.94**

30 Priority: **16.12.93 KR 9327996**

43 Date of publication of application:
21.06.95 Bulletin 95/25

84 Designated Contracting States:
DE FR GB NL

71 Applicant: **DAEWOO ELECTRONICS CO., LTD**
541, 5-Ga, Namdaemoon-Ro
Jung-Gu,
Seoul 100-095 (KR)

72 Inventor: **Kim, Jong-Hoon**
Yonsei Mansion Ba-403,
Yeonnam-Dong
Mapo-Ku,
Seoul (KR)

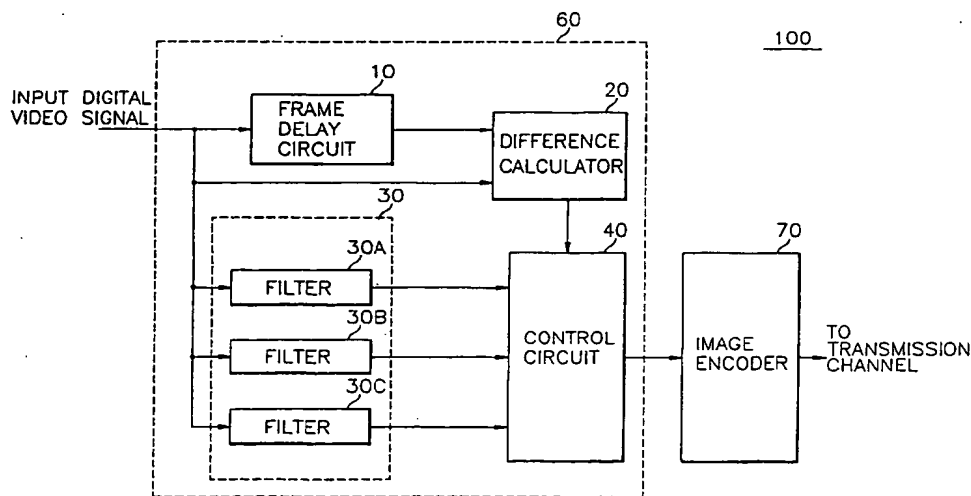
74 Representative: **von Samson-Himmelstjerna,**
Friedrich R., Dipl.-Phys. et al
SAMSON & PARTNER
Widenmayerstrasse 5
D-80538 München (DE)

54 **Pre-processing filter apparatus for use in an image encoding system.**

57 A novel pre-processing filter apparatus for use in an image encoding system, capable of adaptively filtering an input digital video signal, comprises a circuit for delaying a current frame of the input digital video signal by one frame interval; a circuit for generating a difference signal representing the difference between averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel

value for NxN pixels of the current frame, at an identical area of the previous frame and the current frame; two or more filtering circuits arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies; and a control circuit for generating one of the filtered digital video signals in response to the difference signal.

FIG.1



EP 0 659 020 A2

Field of the Invention

The present invention relates to a filter apparatus; and, more particularly, to an improved pre-processing filter apparatus for use in an image encoding system, for adaptively filtering an input digital video signal based on the difference of pixel values between two successive frames.

Description of the Prior Art

In various electronic applications such as high definition television and video telephone systems, an image encoding system has been used to reduce a large volume of data defining each frame of a digital video signal by way of employing various data compression techniques, for example, transform coding using Discrete Cosine Transform, and motion compensation coding based on temporal relationship between a previous and a current frames.

In order to effectively carry out the data compression process and improve the picture quality, most real-time image encoding systems available in the art employ various pre-processing filter apparatus. These filter apparatus serve to eliminate or alleviate temporal noises and perform band limitation to thereby improve the picture quality and coding efficiency.

One of such prior art apparatus is disclosed in an article by Andria Wong et al., "MCPIC: A Video Coding Algorithm for Transmission and Storage Applications", IEEE Communications Magazine, pp.24-32(November,1990), which selectively generates either original data, linearly filtered data, or a weighted sum of the original data and the linearly filtered data based on the absolute value of the difference between the original data and the linearly filtered data. This filter can reduce aliasing effects and noises and improve the image quality significantly. The filtering device, however, may introduce artifacts in those areas where motions occur in relatively high speeds.

U.S. Patent No. 5,231,484 issued to Cesar A. Gonzales et al. offers another prior art apparatus which employs a set of median filters for adaptively providing filtered data based on quantization levels of previously coded frames in order to meet a certain target bit rate.

Since, however, this filter performs filtering of a current frame based on the quantization levels of previously coded frames, the filtered data therefrom may not be able to reflect the details of the current frame.

Summary of the Invention

It is, therefore, a primary object of the invention to provide a pre-processing filter apparatus for use in an image encoding system, capable of adaptively filtering an input digital video signal based on the difference of pixel values between two successive frames, thereby improving the picture quality and the coding efficiency.

In accordance with one aspect of the invention, there is provided a pre-processing filter apparatus for use in an image encoding system for adaptively filtering an input digital video signal wherein the input digital video signal includes a plurality of frames, which comprises: means for delaying a current frame of the input digital video signal by one frame interval; means for generating a difference signal representing the difference between an averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel value for NxN pixels of the current frame, at an identical area of the previous frame and the current frame; two or more filtering means arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies; and control means for generating one of the filtered digital video signals in response to the difference signal.

In accordance with another aspect of the invention, there is provided an image encoding system for adaptively encoding an input digital video signal wherein said input digital video signal includes a plurality of frames, which comprises: means for delaying a current frame of the input digital video signal by one frame interval; means for generating a difference signal representing the difference between an averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel value for NxN pixels of the current frame, at an identical area of the previous frame and the current frame; two or more filtering means arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies; control means for generating one of the filtered digital video signals in response to the difference signal; and means for eliminating redundancies in the generated digital video signal in order to compress the generated digital video signal to a manageable size for the transmission thereof.

Brief Description of the Drawing

The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments taken in conjunction with the accompanying drawing(Fig.1) which is a block diagram illustrating

a pre-processing filter apparatus in accordance with the present invention.

Detailed Description of the Preferred Embodiments

Referring to Fig. 1, there is shown an image encoding system 100 having a pre-processing filter apparatus 60 in accordance with a preferred embodiment of the present invention.

The image encoding system 100 comprises the pre-processing filter apparatus 60 and an image encoder 70 wherein the pre-processing filter apparatus 60 includes a frame delay circuit 10, a difference calculator 20, a filtering device 30 and a control circuit 40.

In the pre-processing filter apparatus 60, an input digital video signal is generated from a video frame source, e.g., video camera(not shown), and applied to the frame delay circuit 10, the difference calculator 20 and the filtering device 30. The input digital video signal comprises a series of video frames, each of the video frames being divided into a plurality of blocks of an identical size. The frame delay circuit 10 has a frame buffer memory wherein the input digital video signal is delayed by one frame interval. The delayed digital video signal is then applied to the difference calculator 20 as previous frame data.

The difference calculator 20 receives current frame data directly fed from the video frame source and the previous frame data from the frame delay circuit 10 and compares each block in the current frame with a corresponding block positioned at the same location of the previous frame to thereby generate a non-motion compensated difference signal representing the differences between pixel values of the two blocks. The difference signal can be obtained by comparing an averaged pixel value for $N \times N$, e.g., 8×8 , pixels of the previous frame with an averaged pixel value for 8×8 pixels of the current frame, at an identical area of the previous frame and the current frame. Subsequently, the difference signals obtained at the difference calculator 20 are sequentially applied to the control circuit 40.

In the meanwhile, the filtering device 30 receives the input digital video signal of the current frame directly fed from the video frame source and performs a filtering process on the current frame, e.g., on a 8×8 pixel basis which is identical to the process unit for the difference calculation in the difference calculator 20, by using a plurality of filters having predetermined cutoff frequencies different from each other. That is, the filter device 30 includes M , e.g., 3, conventional low pass filters 30A to 30C, which are coupled in a parallel manner in order to simultaneously perform the filtering process for the current frame with cutoff frequencies CF_1 , CF_2 and CF_3 , respectively, wherein

$CF_1 < CF_2 < CF_3$. Each of the low pass filters can be implemented by using such digital filters as a Median filter and Laplacian filter well known in the art.

It should be noted that the number of filters and the cutoff frequencies thereof can be determined based on the required coding efficiency and picture quality of the image encoding system.

The digital video signals for each block of the current frame filtered at the filters 30A to 30C and the corresponding difference signal obtained at the difference calculator 20 are simultaneously applied to the control circuit 40 which serves to generate, as an output signal, one of the filtered digital video signals in response to the corresponding difference signal from the difference calculator 20.

For instance, if the difference signal is smaller than or equal to a first predetermined threshold value TH_1 , the control circuit 40 outputs a filtered digital video signal from the filter 30C in order to decrease data compression rates, and if the difference signal is greater than or equal to a 2nd predetermined threshold value TH_2 from the difference calculator 20, it outputs a filtered digital video signal from the filter 30A in order to increase data compression rates. Also, if the difference signal has a value between the 1st predetermined threshold value TH_1 and the 2nd predetermined threshold value TH_2 , it outputs a filtered digital video signal from the filter 30B, wherein the 1st and 2nd threshold values TH_1 and TH_2 are positive integers with TH_2 being greater than TH_1 . As a result, the present invention is capable of performing a pre-processing filtering operation that best reflects actual human visual characteristics.

It should be noted that the threshold values in the control circuit can be determined based on the required coding efficiency and picture quality of the image encoding system.

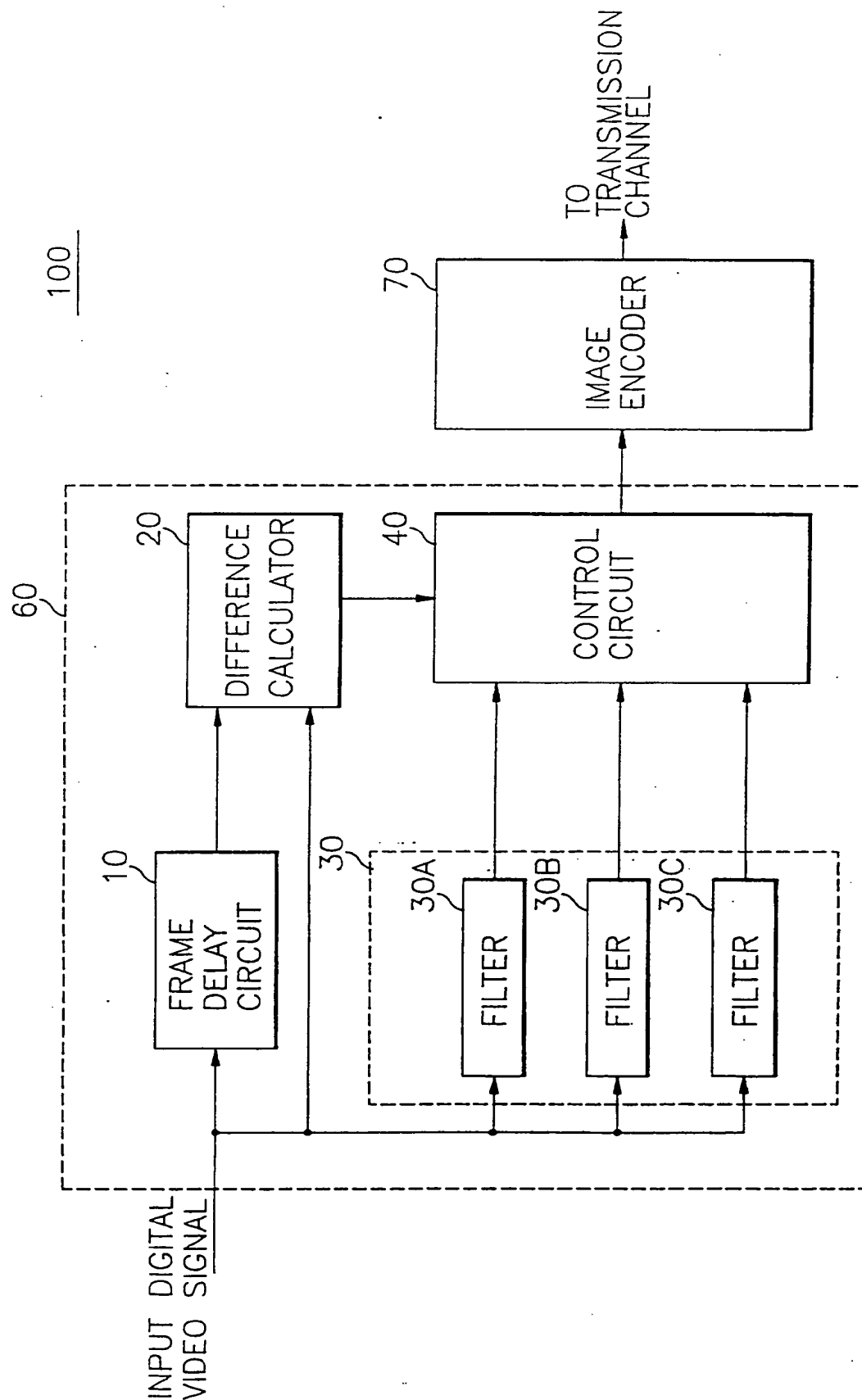
The outputted digital video signal from the control circuit 40 is then applied to the image encoder 70 which serves to compress the outputted digital video signal by using, e.g., a discrete cosine transformer, a quantizer and a variable length coder as well known in the art. That is, the image encoder 70 eliminates redundancies in the outputted digital video signal from the control circuit 40 in order to compress the digital video signal to a more manageable size for the transmission thereof.

While the present invention has been shown and described with reference to the particular embodiments, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims.

Claims

1. A pre-processing filter apparatus for use in an image encoding system for adaptively filtering an input digital video signal wherein the input digital video signal includes a plurality of frames, which comprises:
 - means for delaying a current frame of the input digital video signal by one frame interval;
 - means for generating a difference signal representing the difference between an averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel value for NxN pixels of the current frame, at an identical area of the previous frame and the current frame;
 - two or more filtering means arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies; and
 - control means for generating one of the filtered digital video signals in response to the difference signal.
2. An image encoding system for adaptively encoding an input digital video signal wherein said input digital video signal includes a plurality of frames, which comprises:
 - means for delaying a current frame of the input digital video signal by one frame interval;
 - means for generating a difference signal representing the difference between an averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel value for NxN pixels of the current frame, at an identical area of the previous frame and the current frame;
 - two or more filtering means arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies;
 - control means for generating one of the filtered digital video signals in response to the difference signal; and
 - means for eliminating redundancies in the generated digital video signal in order to compress the generated digital video signal to a manageable size for the transmission thereof.

FIG. 1



(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 659 020 A3

(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
07.02.1996 Bulletin 1996/06

(51) Int. Cl.⁶: H04N 7/26

(43) Date of publication A2:
21.06.1995 Bulletin 1995/25

(21) Application number: 94119781.6

(22) Date of filing: 14.12.1994

(84) Designated Contracting States:
DE FR GB NL

(30) Priority: 16.12.1993 KR 9327996

(71) Applicant: DAEWOO ELECTRONICS CO., LTD
Jung-Gu, Seoul 100-095 (KR)

(72) Inventor: Kim, Jong-Hoon
Team 2 of Video Research Center
Jung-Gu, Seoul (KR)

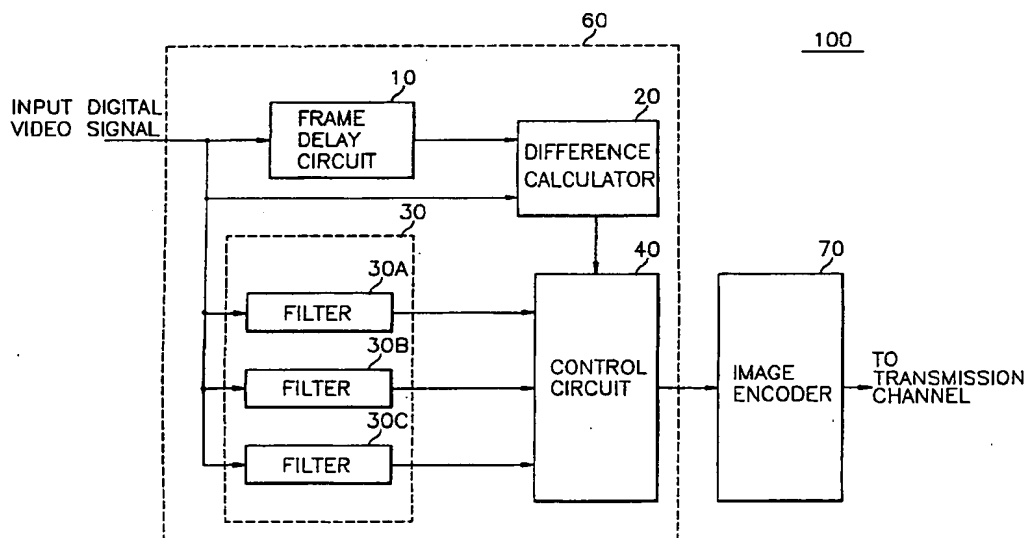
(74) Representative: von Samson-Himmelstjerna,
Friedrich R., Dipl.-Phys. et al
D-80538 München (DE)

(54) Pre-processing filter apparatus for use in an image encoding system

(57) A novel pre-processing filter apparatus for use in an image encoding system, capable of adaptively filtering an input digital video signal, comprises a circuit for delaying a current frame of the input digital video signal by one frame interval; a circuit for generating a difference signal representing the difference between averaged pixel value for NxN pixels of the delayed previous frame and an averaged pixel value for NxN pixels of the current

frame, at an identical area of the previous frame and the current frame; two or more filtering circuits arranged in parallel for filtering the input digital video signal, respectively, each of said filtering means having different cutoff frequencies; and a control circuit for generating one of the filtered digital video signals in response to the difference signal.

FIG.1



EP 0 659 020 A3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 9781

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	SIGNAL PROCESSING OF HDTV, III, 4 September 1991 TURIN, IT, pages 319-328, XP 000379969 ERNST 'Motion Compensated Interpolation for Advanced Standards Conversion and Noise Reduction' * page 323, paragraph 3.2 - page 327, paragraph 4.3 *	1,2	H04N7/26
X	WO-A-93 17520 (BRITISH BROADCASTING CORPORATION) * the whole document *	1,2	
X	ICC-87 PROCEEDINGS, June 1987 SEATTLE, WA, pages 5.1.1-5.1.5, YASHIMA ET AL. 'A highly efficient Coding Method for HDTV Signals' * the whole document *	1,2	
X	EP-A-0 563 644 (SIEMENS CORP. RESEARCH INC.) * the whole document *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 12 no. 362 (E-663) ,28 September 1988 & JP-A-63 114486 (ALPS ELECTRIC CO LTD) 19 May 1988, * abstract *	1,2	H04N
A	EP-A-0 314 269 (PIONEER ELECTRONIC CORP) * the whole document *	1,2	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 December 1995	Examiner Foglia, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 (03.82) (P4/C01)